

Mini-TES Observations of Comanche Carbonate and its Distribution

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The discovery by the Spirit rover of outcrops rich in Mg-Fe carbonate [Morris *et al.*, 2010] represents another manifestation of a diverse aqueous history in Gusev crater. In 2005, observations by the Mössbauer spectrometer (MB) on outcrops dubbed Comanche provided initial indication of Fe-Mg carbonate that was subsequently supported by analysis of elemental data from the Alpha Particle X-ray Spectrometer (APXS). The recognition of a carbonate component in thermal infrared spectra measured by the Miniature Thermal Emission Spectrometer (Mini-TES) was significantly delayed due to dust contamination of the instrument's optics. With the implementation of a viable dust correction, the Comanche spectra were revisited and presented clear and compelling evidence for a Mg-Fe carbonate component that could be as much as a third of the total mineral abundance. The data from all three instruments in combination are best matched by Mg-Fe carbonate with an abundance of 16-34 wt%.

Mini-TES spectra were acquired for 12 targets at various locations on the Comanche (4-5 m long) and Comanche Spur (1-2 m long) outcrops, the latter being the location of the MB and APXS measurements. The two outcrops are spectrally comparable and share similar morphology and texture based on color images from the Panoramic Camera (Pancam). The highest quality Mini-TES spectrum comes from the larger Comanche outcrop on a target named Saupitty. Linear least squares modeling of the Saupitty spectrum employed a library of laboratory spectra tailored for consistency with the APXS and MB data and included spectra representing Martian dust, a "slope" spectrum to account for any temperature determination errors, and a blackbody spectrum to account for differences in spectral contrast between the laboratory and Mini-TES spectrum. Successful modeling of the Comanche Saupitty spectrum required one or more carbonate phases to obtain a good fit. Excluding all carbonates from the full starting library more than doubled the root-mean-squared error of the model fit (0.147% vs. 0.299%). Because Mg-Fe carbonate and Ca-Mg carbonate (dolomite) are so spectrally similar over the range used for modeling, both provide a comparable fit. However, Ca-rich carbonates like dolomite are precluded based on APXS data and are inconsistent with MB results.

The Comanche carbonate rocks are stratigraphically above a set of olivine-rich volcanoclastic rocks known as Algonquin class that mantle the Haskin Ridge feature of the Columbia Hills. Based on ~50 Mini-TES observations, the Comanche outcrops are the only rocks that host abundant carbonate. However, a target at the base of the larger Comanche outcrop appears spectrally transitional between the carbonate and olivine units. This transitional spectral character applies to additional outcrops a few 10s of meters away from Comanche that also appear stratigraphically transitional. Additional work will attempt to establish whether we are seeing an alteration horizon or depositional unit associated with the emplacement Comanche carbonate.

Morris, R. V., et al. (2010), Identification of carbonate-rich outcrops on Mars by the Spirit rover, *Science*, 329(5990), 421-424.